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RECONSIDERATION OF THE EVIDENCE FOR A COMMON DINOSAUR-AVIAN STEM IN THE PERMIAN.

DINOSAUR CONTRIBUTIONS, No. 4.[1]

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THE relation of dinosaurs to birds has been one of the most attractive problems of comparative anatomy during the thirty-seven years which have elapsed since Gegenbaur's observation that the tibiotarsus of Compsognathus, one of the smallest carnivorous dinosaurs, closely resembles that of the bird.

Since a number of new avian resemblances have recently been discovered among dinosaurs, it seems important to reconsider this much debated problem.

I. AVIAN RESEMBLANCES IN CARNIVOROUS BIPEDAL DINOSAURS.

We owe to Fürbringer ('88, p. 1592) a valuable historical summary of the literature and progress of opinion. The recognition of avian characters among dinosaurs has been generally

[1] Presented before the American Association for the Advancement of Science, Section Zoölogy, June 27, 1900.

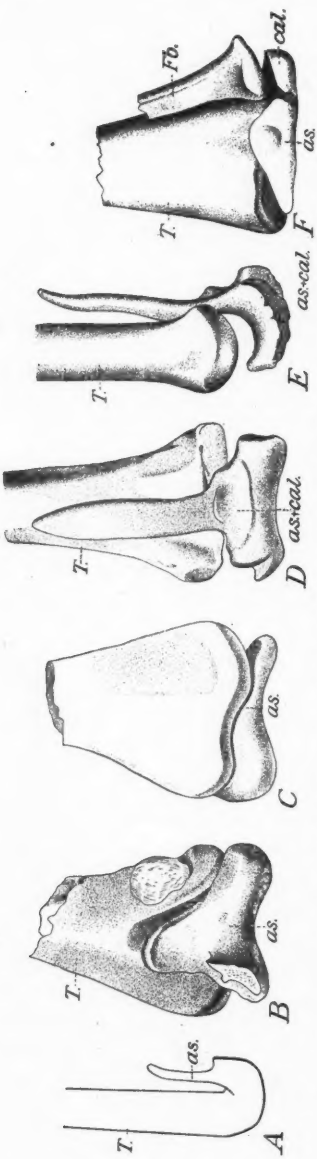


FIG. 1. — Ankle joint of dinosaurs and birds, tibiotarsus. *A*, pigeon (Columba), after Baur; *B*, carnivorous dinosaur (Megalosaurus), after Cuvier; *C*, the same, back view; *D*, young ostrich (Struthio), after Baur; *E*, the same, from the side; *F*, Ornithotarsus, from Baur, after Cope.

attributed to Cope and Huxley; but it appears that Gegenbaur enjoys the priority; for, in 1864 ('**64**), he pointed out that Compsognathus in the structure of its tarsus presents a transition stage between birds and reptiles, or a species of double relationship, which in fact pervades the entire skeleton. Cope ('**66**, p. 317; '**67**, pp. 234, 235; '**69**, p. 123) made a similar observation in Lælaps, the great carnivorous Upper Cretaceous dinosaur, and considered the carnivorous dinosaurs in general as intermediate in position between reptiles and birds, adding to the list of avian characters the elongation of the vertebræ of the neck and the very light construction of the arches of the skull.

Unaware of Cope's observations, Huxley's attention was directed to the matter by Professor Phillips's collection of carnivorous dinosaur (Megalosaurus) remains in the Oxford Museum; fresh from his memoir on the classification of birds, published in 1867, his eye was

keen for avian resemblances, and he at once noted that the ilium of Megalosaurus was bird-like. In fact, Phillips had previously noted the resemblance of this bone to that of Apteryx.

Stimulated to further comparison, Huxley ('**69**, pp. 15 f.) observed other avian features, *viz.*, that the ischium of dinosaurs extends back parallel with the ilium; that the pre-acetabular process, or pubic peduncle of the ilium, extends further downward than the post-acetabular, or ischial peduncle; that the acetabulum itself is partly open; that the limb bones are distinctly tubular; that the scapulo-coracoid elements are anchylosed together; that the sacrum is partly ornithic, partly reptilian; that the femur is vertical to the body, its head extending outward into the acetabulum; that the tibia possesses a prominent procnemial crest; that the astragalus embraces the lower end of the tibia. Huxley concluded ('**68**) "there could be no doubt that the hind quarters of Dinosauria wonderfully approached

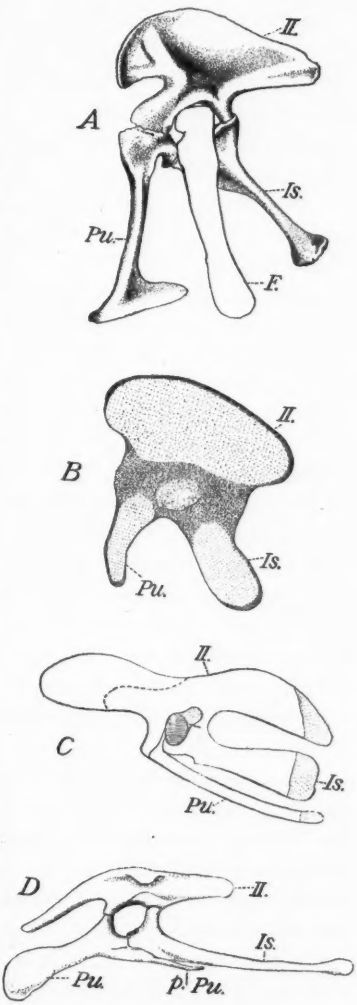


FIG. 2. — Pelvic arch of left side, dinosaurs and birds. *A*, carnivorous dinosaur (Allosaurus), triradiate type, after Marsh; *B*, embryonic bird (Larus), triradiate type, after Mehnert; *C*, adult bird, pubis rotated backwards, after Gegenbaur; *D*, iguanodont dinosaur, vestigial postpubis, quadri-radiate type, after Marsh.

those of birds in their general structure, and, therefore, that these extinct reptiles were more closely allied to birds than any which now lived." He did not commit himself to the theory of direct ancestry, however, as shown in the following passage: "It may be regarded as certain that we have no knowledge of the animals which linked reptiles and birds genetically, and that the Dinosauria, with Compsognathus, Archæopteryx, and the struthious birds only help us to form a reasonable conception of what these intermediate forms may have been." In one important anatomical point Huxley was in error, since he believed that the pubis of dinosaurs, like that of birds, was directed backwards; whereas we now know that in all dinosaurs the pubis is directed forwards, like that of other reptiles. Huxley's ideas culminated in his proposal of the group Ornithoscelida, or "bird-limbed" reptiles, to embrace two suborders, Dinosauria and Compsognatha. The latest expression of Huxley's opinion is found in his paper on the "Respiratory Organs of Apteryx" ('82, p. 569): "Thus, notwithstanding all the points of difference, there is a fundamental resemblance between the respiratory organs of birds and those of crocodiles *pointing to some common form (doubtless exemplified by some of the extinct Dinosauria), of which both are modifications.*" (The italics are our own.) Huxley's final view, therefore, was that birds sprang from some primitive and unknown type of dinosaur.

The conception of direct descent of birds from dinosaurs gained ground until it reached the force of positive theory in the writings of Hoernes, and especially of Marsh, as seen in the following paragraph ('77, p. 228): "It is now generally admitted by biologists who have made a study of the vertebrates that birds have come down to us through the dinosaurs, and the close affinity of the latter with recent struthious birds will hardly be questioned." Subsequently, however, Marsh ('80, p. 188) pointed out that the absence of feathers in dinosaurs and pterosaurs and the presence of a free quadrate in birds rendered it probable that birds descended not from dinosaurs but from a more ancient sauropsid form.

II. Rise of the Theory of Homoplasy.

The theory of direct descent was more or less strongly supported by many anatomists, but there were also many dissenters. Seeley (Fürbringer, '88, p. 1595) pointed out with truth that the direct descent theory rested upon resemblances of certain bones of the pelvis and posterior extremities which are found only in certain genera and are not characteristic of the whole group.

Vogt also advocated the homoplastic view. Their opinions ('79) were given by Seeley ('81) as follows:

"'All the characters whereon are based the claim of dinosaurs to be regarded as the ancestors of birds are only related to the power of keeping an upright position upon the hind feet.'

"Vogt believes that certain dinosaurs were leaping or perching animals, and infers that the avian characters of the pelvis and hind limbs thus came to be evolved from community of habit with birds. He is, however, not indisposed to see in dinosaurs possible parents of the ratites; while the Archæopteryx would be the ancestor of the birds that fly."

In 1882 Dollo also ('82, '83) advanced the more modern idea that the resemblances in the pelvis and hind limbs might as well be considered adaptive as genetic. Baur, however ('83, pp. 417 f.; '85 (2), pp. 446 f.), held firmly to the idea of direct descent, singularly enough, not through the carnivorous dinosaurs, but through the herbivorous iguanodont types. Dames, in opposition to Baur ('84), concluded with Vogt, Seeley, and Dollo that the resemblances were due to adaptation, and that the direct ancestors of the birds could not be designated. A still more conservative view, that the resemblances were altogether due to adaptation and not at all indicative of genetic descent, was taken by Richard Owen, by W. K. Parker ('87), by Cleland ('87), and by Mehnert ('88). In the mean time, however, Owen, Cope, Mivart, Wiedersheim, had more or less strongly advocated the theory of the derivation of the carinate birds from the pterosaurs. Thus arose the extreme theory of Mivart ('81) that the carinate birds sprang from pterosaurs,

and the ratite birds from dinosaurs. This was supported by Wiedersheim ('86).

As a result of his own detailed review and comparison, Fürbringer in his great monograph upon birds ('88, p. 1624) concludes that the direct descent of birds from any known type of Dinosauria is excluded; that the birds are monophyletic; that the resemblances between dinosaurs and birds are all "convergence-analogies" and "parallels" due to relationship of the "middle grade"; more definitely ('88, p. 1630), he regards Dinosauria, Crocodilia, and Lacertilia in the order named as the nearest relatives of birds, and believes that the stem of the birds is to be sought in a common sauropsidan ancestor lying between the Dinosauria, the Crocodilia, and the Lacertilia; that this stem, as Marsh had already supposed, is to be found in the last division of the Palæozoic, namely, the Permian; here occurred the first differentiation of fine sauropsidan scales into feathers.

The problem thus presents itself now in three forms: (1) are birds directly descended from primitive dinosaurs? (2) have birds and dinosaurs originated from a common stock? (3) are the remarkable resemblances between these two groups entirely due to parallelism or homoplasy?

Before discussing this triple problem we may continue with the subject of the resemblances and differences, or positive and negative evidence.

III. Additional Avian Resemblances in Bipedal Dinosaurs.

Cervical Vertebral Formula. — Fürbringer ('88) observes that the cervical + cervico-dorsal vertebræ of birds vary from ten to eleven (Archæopteryx) to twenty to twenty-five in the larger, long-necked forms, indicating that the number of vertebræ is distinctively an adaptive character. More in detail, we may give the avian formulæ as follows:

VERTEBRAL FORMULÆ OF BIRDS.[1]

	Cervicals (with Coalesced Ribs).	Cervico-Dorsals (with Ribs not attached to Sternum).	Dorsals (with Ribs partly attached to Sternum).	Total Number of Cervico-Dorsals and Dorsals.	Total Number of Presacrals or Cervicals, Cervico-Dorsals, and Dorsals.	Sacrals (including Pelvic Vertebræ).	Caudals.
Archæopteryx[2] . .	10, 11	—	—	11 or 12	21?	5, 6	20 or 21
Apteryx	16	1, 2	7, 8	8–10	24–26	—	—
Dromæus	20, 21	2–4	5–7	7–11	27–32	—	—
Struthio	20	2, 3	5	7, 8	27, 28	—	—
Hesperornis[3] . . .	17	—	—	—	23	14	12
Anser cinereus . . .	18	2	4	6	24	—	—
Cygnus olor	23	2	4, 5	6, 7	29, 30	—	—
Most Passeres . . .	14	2, 3	5	7, 8	21, 22	—	—

From this table can be drawn the general conclusion, positive or favorable to the common dinosaur-avian stem theory, that primitive birds had numerous cervicals, few dorsals, and numerous caudals.

Pubis of Birds.—An important negative contribution to this problem is that upon the pubis by Mehnert ('**88**), who shows that the pubis of birds in the earliest stages of development is directed forwards, like that of dinosaurs and other reptiles, and is *secondarily* shifted backwards, parallel with the ischium; that the *processus ileopectineus*, rising mainly from the ilium, is a secondary structure, exclusively characteristic of birds, which has no homology with the falsely called prepubis of dinosaurs; thus the various comparisons of the bird and dinosaur pelvis by Huxley and others lose one of their strongest supports. The primitive (or embryonic) bird pelvis, however, is triradiate and resembles that of the primitive carnivorous dinosaurs. The secondary, or adaptive, bird pelvis is totally different from that of any dinosaur. This militates against the theory of the derivation of birds from any specialized dinosaurs, such as the Iguanodontia or Megalosauria, but not against the theory of a common dinosaur-avian stem.

[1] Mainly from Newton, '**93**–'**96**, p. 849.
[2] Fürbringer, '**88**. [3] Marsh, '**80**.

Musculature of Leg. — Dollo ('83, 2) adds an extremely interesting resemblance in his comparison of the attachment of the muscles connecting the back of the femur with the ischium and with the caudal vertebræ in birds and in Iguanodon; he shows that the so-called "third trochanter" of birds and dinosaurs, to which the name "fourth trochanter" should be

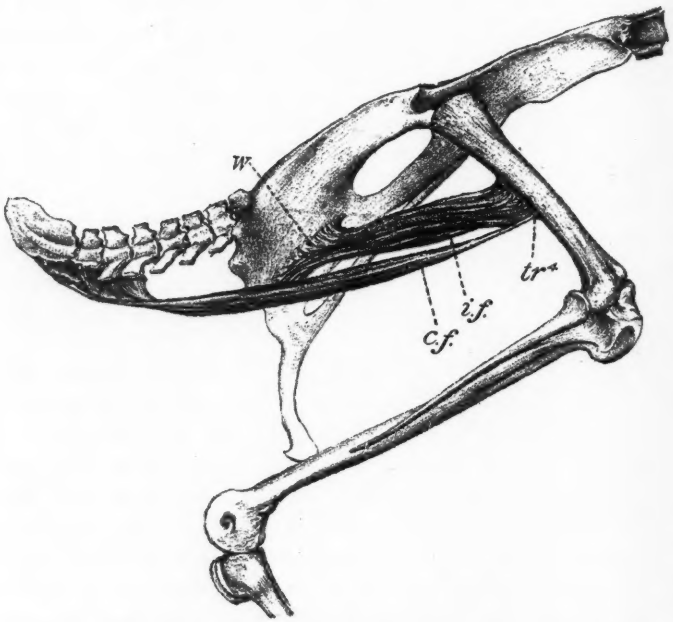


FIG. 3. — Right hind limb of duck (Anas boschas), showing, *tr*⁴, the supposed 4th trochanter; *i.f.*, ischio-femoral; *c.f.*, caudo-femoral muscles. After Dollo.

applied, is actually a process quite distinct from the "third trochanter" of mammals, that its function is especially for the insertion of the "ischio-femoral" muscle and for the origin of the "caudo-femoral" muscle; he concludes that the femur of Iguanodon is constructed upon the bird and not upon the reptilian type, and, as a corollary of this, that the extrinsic musculature of the tail in Iguanodon presented close resemblances to the corresponding musculature in the bird. As

shown in Fig. 3 there are two muscles at the back of the femur, the larger of which, or "ischio-femoral," passes from the crest of the fourth trochanter back to the ischium; while the more slender "caudo-femoral" passes from the apex of the fourth trochanter back to the caudals and causes the sudden lateral movements of the tail, so characteristic of the duck. The pronounced development of this character in Iguanodon indicates a very powerful "caudo-femoral" muscle in this type. Further, Dollo observes that Hesperornis, with its well-developed tail, presents a condition of the fourth trochanter intermediate between the avian and dinosaurian types.

FIG. 4.—Carnivorous dinosaur (Allosaurus), right hind limb, × 1/8. After Osborn.

Returning to the carnivorous bipedal dinosaurs, Osborn ('99 (2), p. 163) described the complete hand and foot of Megalosaurus from the famous Bone Cabin Quarry. Of greatest interest is the first digit, or hallux, not before described; proximally the metatarsal of this toe (I) persists and fits into a shallow groove of metatarsal II; the

shaft is, however, entirely interrupted in the middle portion; distally it is fitted to the rounder posterior portion of the shaft of metatarsal II, demonstrating that it was directed inward like the small hallux of Apteryx; unlike this bird, however,

FIG. 5. — Hind foot of bird (Apteryx). Internal view of right tibiotarsus and pes. After Osborn.

Megalosaurus possessed a complete and functional phalanx and claw upon the hallux, which undoubtedly were of service in grasping, as in carnivorous birds.

IV. AVIAN RESEMBLANCES IN QUADRUPEDAL DINOSAURS.

It will be noted that all the resemblances above recorded relate exclusively to the bipedal bird-footed carnivorous and herbivorous dinosaurs, namely, to the Megalosauria and Iguanodontia. The resemblances pointed out below refer to the entirely distinct group of Cetiosauria or Sauropoda, which, in contrast, are quadrupedal and reptile-footed.

In describing Camarasaurus, Osborn ('98, p. 220) directed attention to the resemblance between the cervicals and anterior

"cervico-dorsals" of the Sauropoda and those of the emeu (Dromæus), as follows: "The long neck, similar in structure and almost as flexible as that of an emeu (Dromæus), could thus pass through a prodigious arc in the search for food, either under or above water. The neck motion partly involved the anterior non-spine-bearing dorsals (vertebræ with free ribs, equivalent to the 'cervico-dorsals' of birds), as in Dromæus, behind which the comparatively inflexible, large, spine-bearing dorsals rose to maximum height in the sacrum for the inser-

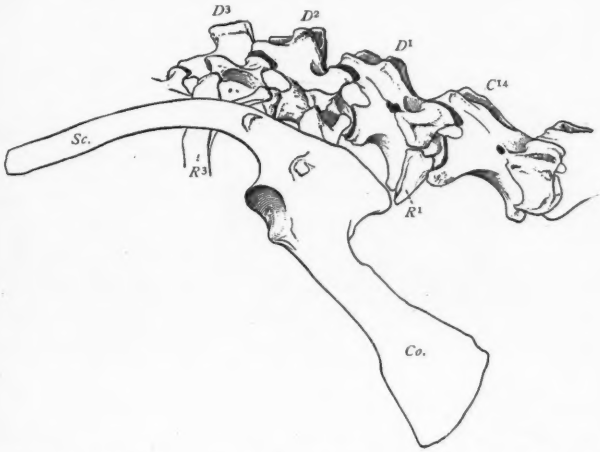


FIG. 6. — Neck of bird (Dromæus). Cervicals 13–14 and cervico-dorsals 1–2 entirely lacking median spines; dorsal 3 with a large blunt median spine. After Osborn.

tion of the *ligamentum nuchæ* and elevator muscles." . . . The importance of such an hypothesis of function will appear in the following description and discussion, and it applies to all the Cetiosauria, namely, to the Morosaurus and Diplodocus types as well, which, so far as known, *are uniform with the camarasaur type in the peculiar bird-like arrangement of the posterior cervicals and anterior dorsals.* (See Fig. 7.)

Again, in the description of Diplodocus, Osborn ('**99** (1), p. 200) pointed out the resemblances in the relations of the posterior ribs to those of Apteryx. Two features were brought out, namely: two of the ribs actually underlie the anterior

border of the ilium, both in Diplodocus and Apteryx; the last dorsal vertebra of Diplodocus coalesces with the superior border of the ilium by a bar, which may be considered either a metamorphosed rib or an expansion of the metapophysial lamina: if this is a rib, Diplodocus presents a condition analogous to that in Struthio, in which the last vertebra and rib, technically known as a "pelvic vertebra," is all but united with the ilium. (See Figs. 8 and 9.)

Dorsal Vertebral Formula. — The latest contribution to this subject results from the explorations of 1899 in the dinosaur beds of Wyoming. Holland (**1900**, p. 817) shows from the explorations of

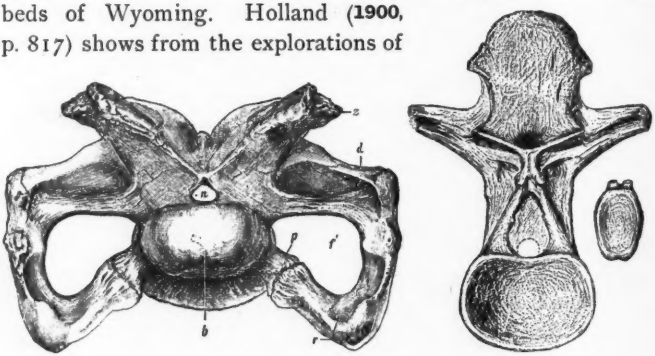


FIG. 7. { Brontosaurus. Posterior cervical, lacking median spine. After Marsh.
Camarasaurus. Anterior dorsal vertebra, with blunt median spine. After Cope.

the Carnegie Museum in the Jurassic of Wyoming that the number of dorsal vertebræ in Diplodocus has been overestimated hitherto by Osborn; that this animal possesses in fact only ten dorsal vertebræ, the entire vertebral formula being estimated as follows:

Cervicals	at least	13
Dorsals		10
Sacrals		4
Caudals		32–35

Contemporaneous with this discovery is that of the American Museum party, that the dorsal vertebræ of Morosaurus also number *ten.*

Thus, in two of the largest Cetiosauria or Sauropoda we have an extremely short back, resembling the short back of birds, also an extremely long flexible neck, a very rigid attachment between the sacrum and ilium, correlated with the power of *temporarily raising the entire presacral portion* of the body.

The significance of these avian resemblances in the neck and trunk of these gigantic dinosaurs is rather homoplastic than genetic, for the peculiar paired cervical and cervico-dorsal spines, the posterior abdominal ribs, the lengthened preacetabular iliac bar, correlated with certain feeding motions, are bird-like structures mingled with other non-bird-like structures too numerous to mention. So also with the resemblances among the bipedal dinosaurs, in which the *presacral portion of the body is permanently raised*, bird-like and non-bird-like structures appear in close propinquity.

The main avian character pervading all Dinosauria is the one originally observed by Gegenbaur, namely, the close junction of the astragalus with the tibia or tendency to form a tibiotarsus. However, where there is so much smoke there may be some fire, and we may now proceed to look into the probability of the existence of a primitive bipedal dinosaur-avian ancestor.

V. The Clawed Quadrupedal Ancestry of Birds.

Pycraft ('96, p. 261) has recently discussed with care the osteology of Archæopteryx. In opposition to the view of Hurst, that the manus retains five digits, two of which were used in climbing trees, Pycraft supports the older view, that digits I, II, III are the only ones represented, and that digit III, as in the Archosauria[1] generally, and in the Dinosauria in particular, had four phalanges, the terminal of which was armed with a claw. In addition to these reptilian characters are the thecodont, or socketed teeth, the flat, or amphiplatyan,

[1] "Archosauria" is a term employed by Cope for reptiles with two cranial arches at the back of the skull, namely, Rhynchocephalia, Crocodilia, and Dinosauria. In the writer's opinion this group should be extended to include the Lacertilia, in which one arch has been lost.

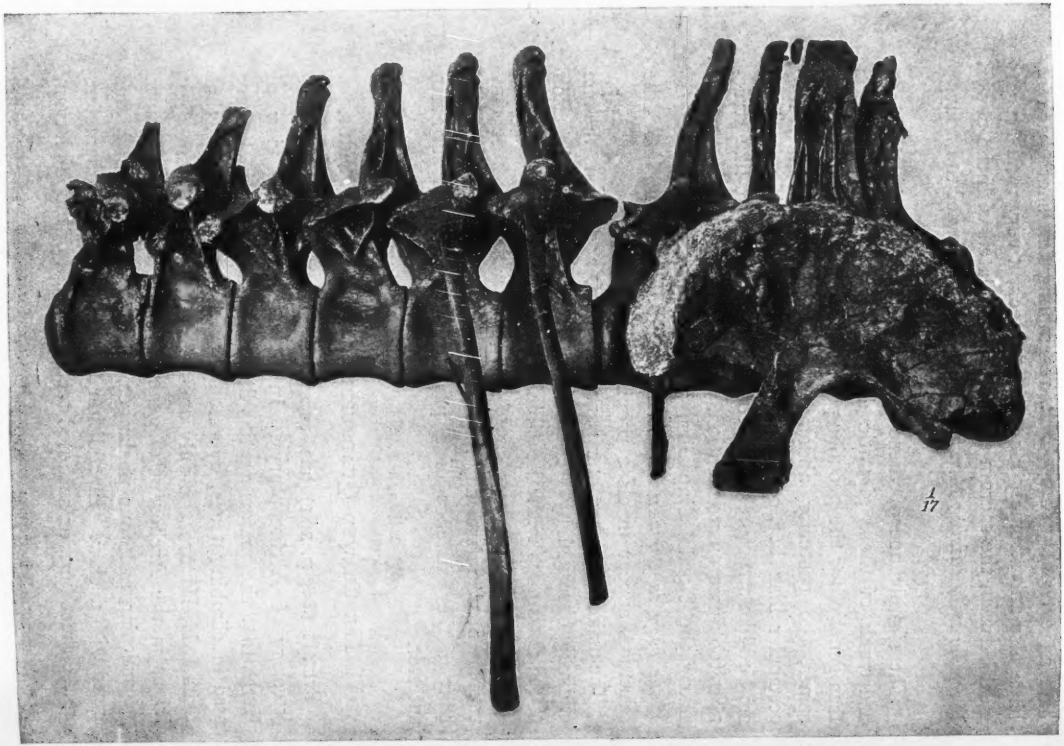
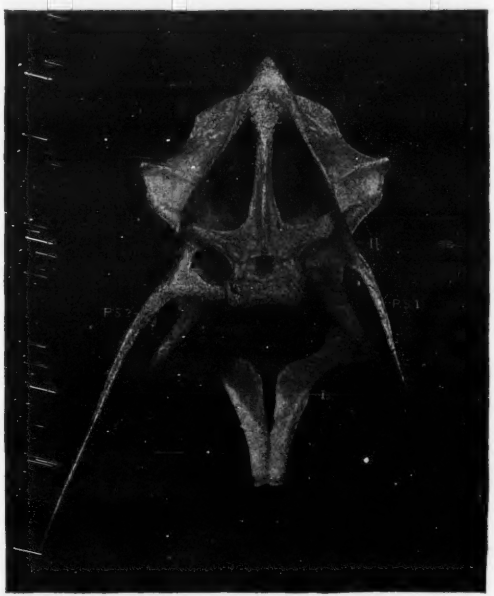


FIG. 8. — Diplodocus. Ninth dorsal vertebra with 9th free rib behind ilium, 10th dorsal, or " pelvic " vertebra, with rib element coalesced with ilium. After Osborn.

FIG. 9. — **Apteryx.** Ilium overlapping the two posterior ribs 9th and 10th, as in Diplodocus. Decided *ileo-pectineal* process.. Uncinate processes as in Rhynchocephalia.



Struthio. On right side, *P.S.*2, 7th dorsal; on left side, *P.S.*1, 8th dorsal, overlapped by ilium; 9th and 10th dorsals absorbed in sacrum.

vertebral centra, the numerous caudal vertebræ. As regards the ribs, Pycraft considers it unsafe to infer that they lack uncinate processes, since these would be readily macerated off; the cervical ribs were slender and movably articulated. Abdominal ribs appear to have been present, as in the Crocodilia and Proganosauria.

In connection with the clawed quadrupedal stage in the history of birds, Opisthocomus, the Hoactzin, proves to be of exceptional interest, "for," as Pycraft remarks, "it is probable

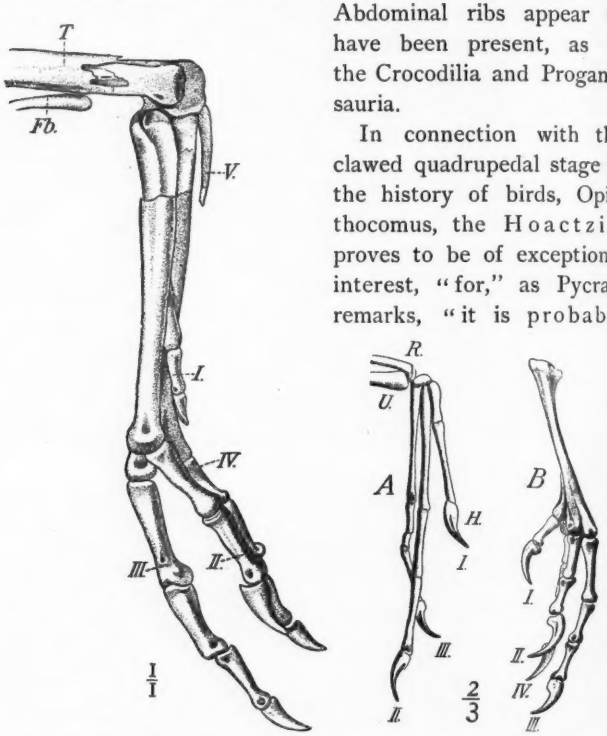


FIG. 10. Compsognathus. Right pes, × ½. After Baur.
Archæopteryx. *A*, right manus, × ⅔, from Headley, after Dames; *B*, right pes, × ⅔, after Owen.
T, tibia; *Fb*, fibula; *R*, radius; *U*, ulna; *I–V*, metacarpals and metatarsals.

that the peculiar habits of the nestling may be a survival of an order of things handed down from the very dawn of avian development." The young are reared in trees and at an early age climb out of the nest; the hand is considerably longer than the forearm; the pollex (I) is especially long and provided with a large claw; index II has an equally large claw, which is

produced beyond the skin fold that encloses the bases of the quills. These proportions are peculiar to the nestlings; the adults shorten the hand and lose the claws as soon as they have ceased to be of assistance; but, as Pycraft observes, could we discover a yet more primitive form "it is probable we should find that the claws and long hand were maintained throughout life." Further light upon the quadrupedal habits of primitive birds is given by the very interesting observation of Dean upon the locomotion of young cormorants, which, when frightened, clamber over irregular surfaces with the assistance of the fore limbs. Young gallinules, coots, and grebes are also quadrupedal in habit.

So far, therefore, as the osteology of Archæopteryx and the embryology and habits of recent birds guide us, the theory of a quadrupedal proganosaurian prototype is not excluded.

VI. The Most Primitive Quadrupedal Land Reptiles.

This suggests a consideration of the Proganosauria, the most primitive representatives of the Hatteria phylum, as one of the possible sources of the birds.

The Proganosauria, Baur (= Proterosauria, Seeley), constitute a suborder of Rhynchocephalia and include some of the most ancient reptiles known of the Permian period. They occupy the cleft between Crocodilia, Lacertilia, and Dinosauria.

In his extremely interesting and important papers upon Palæohatteria and Kadaliosaurus Professor Hermann Credner ('88, '89) has described two proganosaur types from the Permian, near Dresden, one of which approaches most nearly the hypothetical ancestral dinosaur. Palæohatteria, if we may judge by the comparatively unossified extremities of the limb bones, was probably an aquatic type; Kadaliosaurus, on the other hand, was undoubtedly a land type, the limb bones being completely ossified proximally and distally, with spongy interior. The prefix *καδαλίων* refers to the exceptional elongation of the limbs, the proportions of which are well represented in Fig. 11. Professor Credner has pointed out the striking resemblance of the somewhat forward and backward spreading ilium

of this animal to that of a dinosaur. It is further to be noted that, while the forearm is extremely long, the metacarpals are shorter than the metatarsals, which are decidedly long and slender; the skull and shoulder girdle are unfortunately unknown; the number of dorsals is estimated at twenty; there are two sacrals. While the ectepicondylar foramen of the humerus points in the direction of the lizards (in distinction from Palæohatteria, with its entepicondylar foramen), there is no

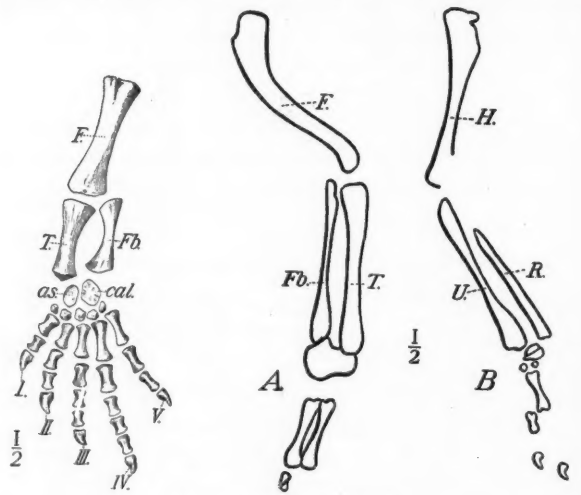


FIG. 11. — Limbs of Proganosauria.

Palæohatteria. A short-limbed, probably amphibious type. Left hind limb. Restored by McGregor, after Credner.

Kadaliosaurus. A long-limbed, probably terrestrial and active type. Metatarsals longer than metacarpals. After Credner.

question that we have here a type which comes very near the dinosaur atavus. The fact that the humerus and femur are of the same length accords with the condition characteristic of the early Cetiosauria, for the Cetiosaurus of Oxford has a humerus and femur of nearly equal length.

The foot structure of Palæohatteria, as restored from Credner's plates by Dr. McGregor (Fig. 11), fulfills all the required ancestral conditions, both for dinosaurian and avian ancestry.

Granting, therefore, for the sake of argument, the hypothetical value of the Proganosauria in the largest sense as

ancestral to all Archosauria, including birds, the crucial question remains, whether birds sprang off independently from a proganosaur stem or from a common dinosaur-avian stem. In the origin of the birds we have to imagine, first, a terrestrial stage, in which bipedal was gradually substituted for quadrupedal progression; it would appear probable that the bipedal progression was first acquired during a terrestrial stage, because the foot of birds is primarily a walking, and not a climbing, organ; second, a cursorial bipedal or, more probably, an arboreal stage, in which both fore limb and tail enjoyed a change of function contemporaneous with the acquisition of feathers.

VII. Correlated Development of Tridactylism and Bipedal Progression.

It appears probable that the ancestral dinosaur was a quadrupedal type, with the body well raised off the ground, distinctively a land animal, because the distinctive specialization of this group appears to have been terrestrial, the Cetiosauria or Sauropoda secondarily acquiring an amphibious mode of life. The manner in which the four-footed primitive dinosaurs acquired the bipedal habit and consequent reduction of the fore limbs and elongation of the hind limbs is beautifully illustrated in Chlamydosaurus of Australia and some other living lizards. As observed by Saville-Kent, this animal in all its rapid movements raises the fore limbs, balances the anterior part of the body with the tail, and runs along rapidly upon the hind limbs. This analogy appears to demonstrate that an important function of the tail was to serve as a balancing organ. (We note in parenthesis that this function is developed among birds.) Kent remarks further: "Such is the construction of the hind foot and its component digits that, when thus running, the central digits only, rest upon the ground. As a consequence of this structural peculiarity, the track made by this lizard when passing erect over damp sand or other impressible soil would be tridactyl, like that of a bird, and would also correspond with the tracks that are left in Mesozoic strata by various typical Dinosauria. This tridigitigrade formula of the

gradation of Chlamydosaurus, induced by the great relative shortness of the first and fifth digits, is distinctly indicated in Fig. 1 of the plate previously referred to."

Thus, tridactylism is correlated with rapid bipedal progression, the inner and outer digits suffering reduction. In fact, a glance at the digital formula of Archosauria shows why tridactylism is a likely resultant of rapid digitigrade progression.

Digits . . .	I	II	III	IV	V
Number	1	1	1	1	1
of	2	2	2	2	2
Phalanges		3	3	3	3
in			4	4	
Archosauria				5	

There is considerable ground for regarding a certain degree of bipedalism as a character common to all dinosaurs. Among the carnivorous Megalosauria there can of course be no question, because this condition marks the oldest Triassic types. Osborn, in Diplodocus, has demonstrated the truth of Cope's conjecture that the quadrupedal cetiosaurs occasionally rose upon their hind limbs. Among the Predentata, the Iguanodontia are typically bipedal, and the iguanodont or quadriradiate structure of the pelvis in the quadrupedal Stegosauria and Ceratopsia has led Dollo to advance the somewhat daring hypothesis that these animals also were at one stage more or less bipedal and that their fixed quadrupedal habit is possibly secondary.

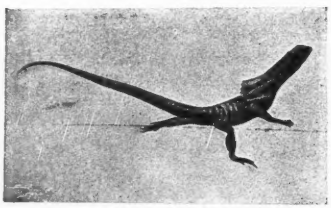


FIG. 12. — Chlamydosaurus in rapid motion. From an instantaneous photograph by Saville-Kent.

VIII. HYPOTHETICAL ORIGIN OF BIRDS FROM A PRIMITIVE BIPEDAL DINOSAUR.

If bipedalism subsequently proves to be a common dinosaur character, it would naturally strengthen the dinosaur-avian stem hypothesis. The presence of a *free quadrate* in birds, a

difficulty which suggested itself to Marsh, is explainable as a secondary character, like the secondarily free quadrate of certain Lacertilia and Ophidia, due to degeneration of one of the cranial arches.

The passage from a quadrupedal to a bipedal type would also mark the transition from the Proganosauria to the Dinosauria, and all that our present knowledge and evidence justify us in saying is that *in this bipedal transition, with its tendency to form the tibiotarsus, the avian phylum may have been given off from the dinosaurian.*

This form of the Huxleyan hypothesis seems more probable than that the avian phylum should have originated quite independently from a quadrupedal proganosaur, because the numerous parallels and resemblances in dinosaur and bird structure, while quite independently evolved, could thus be traced back to a potentially similar inheritance.

Upon the whole, therefore, the dinosaur-avian stem hypothesis deserves not to be discarded but to be very seriously reconsidered in connection with future research and discoveries among birds and dinosaurs.

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THE GALL OF THE MONTEREY PINE.

W. A. CANNON.

ONE species of pine, the Monterey pine,[1] which is especially abundant in the arboretum of the Leland Stanford Junior University, has recently been so seriously affected by a gall that the beauty of a great number of the trees has been greatly impaired, and their total destruction made probable. The gall is caused, as was first observed by Mr. W. A. Snow,[2] by larvæ of a gallfly belonging to the family Cecedomyiidæ.

The gall consists of a malformation of the leaves and leaf bases. The galled leaves vary in length from .5 to 1.5 cm., and their bases are so badly swollen that the leaves are often pear-shaped. The larvæ live in pockets in the swollen leaf bases. The gall occurs on the youngest leaves, and for that reason leaves containing larvæ are to be looked for at the tips of the branches. Where the same branches have been galled several successive seasons their tips appear as if closely clipped and look like great bottle brushes. The galled leaves do not remain so long on the tree as the normal ones.

If one of the galled leaves be examined the autumn after it has been stung, it will be found to contain in its base four or more larvæ. These are without biting mouth-parts, but they are none the less completely enclosed by plant tissues. It was to learn, primarily, how the larvæ got inside of the leaf base, and also to trace the immediate cause of the hypertrophy, that this study was undertaken. To these were added, in the course of the investigation, other questions of physiological interest.

[1] *Pinus radiata* D. Don., *Trans. Linnæan Soc.*, vol. xvii (1836), p. 441; formerly known as *P. insignis* Loudon, *Arb. Brit.*, vol. iv (1838), pp. 2265, f., 2170–2172.

[2] This study was taken up with Mr. Snow, since deceased, and subsequently carried on by Miss Helen Mills. *The Entomological News*, vol. xi (1900), p. 489.

In dealing with the inner morphology of the galled leaf it was not thought necessary for the purpose of this paper to follow minutely all of the changes in the plant tissues during the development of the gall, but rather to observe the conditions of the tissues in well-marked stages of growth, and contrast them with each other and with the conditions in normal leaves.

I.

In the middle of February the young shoot representing the season's growth of the branch is about 3 cm. long and consists of a central axis covered closely with leaf bundles, or fascicles. There are about seventy leaf bundles, or fascicles, to each young shoot. Each bundle is composed of a short secondary branch bearing three leaves, or "needles," which are closely and completely enwrapped by several protective scales. The whole springs from the axil of the primary leaf (Fig. 1). Early in the season each primary leaf completely covers its leaf bundle, but by the middle of February the leaves begin to grow appreciably and soon stretch up above the tip of the primary leaf. At the tip of each young shoot there will be fascicles hidden by the primary leaves, while at the base of the same shoot these bundles may be twice as long as the primary leaves, and between tip and base an intermediate condition may be found. At the time the gallfly is active the majority of leaf bundles are about 2 mm. in length. The length of the leaf bundle in relation to that of the subtending primary leaf and to that of the ovipositor is of great importance in connection with the successful deposition of the eggs.

To learn in what part the eggs were placed, the young shoots were examined in February, during the activity of the gallfly. The eggs were found deposited in masses on the outside of the young shoot. They were placed, also, in great numbers between the leaf fascicles or between the primary leaves and the fascicles they subtend (Fig. 1, *B*), and it was thought at the time that the fly did not deposit the eggs in any other parts. The young shoots were examined to see if some substance, such as formic acid, were not deposited by the fly at the time the eggs

were laid, which might in this case, as in others, stimulate the plant tissues to abnormal growth and thus bring about the gall. The cells, however, adjacent to the masses of eggs did not show the slightest discoloration or shrinkage of contents, nor did they in any other way that could be discovered indicate that substances were deposited which might stimulate or affect the plant tissues. All of the eggs which were placed on the outside of the young shoots disappeared on the first of March. A closer examination of the leaf bundles showed that, in addition to the great numbers of eggs placed on their surfaces, the

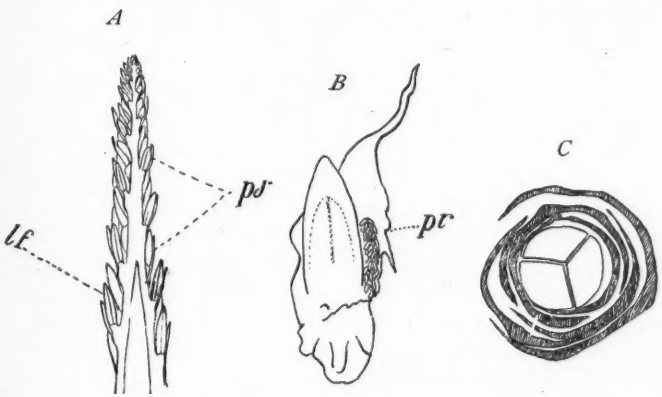

FIG. 1.—*A*, young shoot with leaf fascicles (*lf*) and primary leaves (*pf*). × 2. *B*, dorsal view of a young leaf fascicle with its primary leaf (*pr*) attached, showing a mass of eggs between the two. × *circa* 10. *C*, transverse section of the same with the protecting scales. × *circa* 16.

fly also placed some inside of them. The eggs which were deposited within the leaf fascicles were in much smaller masses than those on the outside. The number of eggs in these masses did not, in any case observed, exceed six. They were found in three positions. Some eggs were between the enwrapping scales, others inside of them but near the tips of the leaves, and still others within and at the bases of the inner scales (Fig. 2, *A*, *B*). These different positions of the eggs might not all be met with in any one bundle, but they were of frequent occurrence. In those cases where the eggs were placed between the scales, and also where they were deposited

within the scales but near the tip of the leaf, they did not give rise to larvæ that matured, because, as will be shown later, the young larvæ were not in contact with living tissue which could give them nourishment. The larvæ take their food only by absorption through the surface of the body. This makes it essential for them to be in contact with living cells, from which the necessary food matters can be abstracted. This condition, namely, that the larvæ must be in physical contact with tissues which will give them food, is fully realized only when the eggs from which they develop are placed at the bases of the inner scales. It is consequently necessary that the distance from the tip of the needles, or in other words the length of the leaves, be approximately the same as the length of the ovipositor of the fly, for only in this way can the eggs be so placed that the larvæ which result from them will live. This exacting condition we find is complied with by most of the leaf bundles of the Monterey pine during the month of February, or during the season of the gallfly's activity.

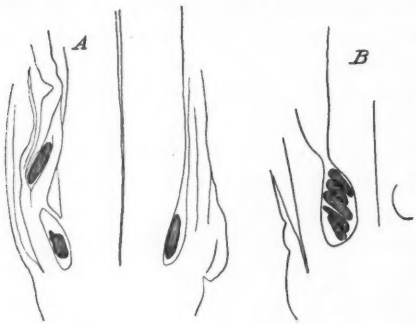

FIG. 2.—*A*, longitudinal section of a leaf fascicle with eggs placed at the base of the leaves and of the inner protecting scales; one egg is also shown between the scales. × 28½. *B*, longitudinal section showing a mass of eggs at the base of the leaf. × 28½.

II.

All of the young leaves grow rapidly in length during the month of March, and the first week in April most of them are approximately 1 cm. long; thus, they have increased about five times in length in somewhat over four weeks (Fig. 3). Up to the first of April there is no apparent difference between the normal and the galled leaves; from this time on, however, the difference in length and diameter between the affected and

the normal leaf bundles, or fascicles, is increasingly marked. By the first of May the normal leaf bundles are about 3 cm. long, and the galled ones from 1 to 1.5 cm. in length. In addition to the difference in length, the bases of the latter are much swollen, and many of the leaves cease to grow in length, although the diameter of their bases continues to increase until autumn (Fig. 4).

FIG. 4. — A galled fascicle sketched in July. Natural size.

To learn what plant tissues were affected, and in what manner, so that some conclusion might be drawn as to the immediate cause of the hypertrophy, there were selected for more careful study leaf bundles taken in April — the season of great changes and development in the leaf bundle. All of the material was fixed in hot alcoholic corrosive sublimate, a saturated solution in 30 per cent alcohol being used.

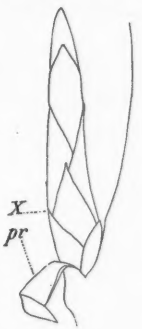

FIG. 3. — Showing the first indication of the hypertrophy at *X*. March 16. × 4.

If a galled leaf bundle is examined in the middle of April or the first of May, the cavities in which the larvæ lie will be

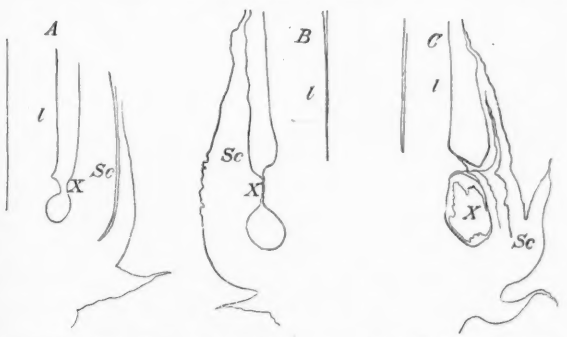

FIG. 5. — Showing the development of the protuberances which enclose the upper part of the larval cavity: *A*, May 1; *B*, July 15; *C*, mature, autumn (*l*, leaf; *Sc*, scale; *X*, development of protuberances and larval cavity). × 28½.

found almost completely developed. The cavity is in the axil of the leaf and is nearly covered above and on the sides by

projections of plant tissue, one from the periphery of the leaf, and another from the inner surface of the inside scale (Fig. 5, *A*). It will be seen by consulting Fig. 6 that the young larvæ are at this time completely surrounded by thin-walled cells, and that the plant tissue which is in contact with the body of the parasite is composed of epidermis, thus showing that the parasite has consumed none of the plant cells or tissues.

The young epidermal cells of the young normal leaf are long, thin-walled, and have little granular contents. The older epidermal cells lose their contents, their outer walls become strongly cutinized, and they serve the plant only as a protective covering.

The epidermal cells of the leaf which are in contact with the larvæ have an appearance quite different from those epidermal cells in the other parts of the leaf. The first difference is noticed in the size and shape of the epidermal cells that line the cavity in which the larvæ lie. They are much longer and deeper than the normal epidermal cells, and they very closely resemble the cells lying beneath them, which are the large mesophyll cells. Furthermore, these epidermal cells are densely filled with granular food matter. Above the larval cavity, where the epidermal cells of the leaf arch over to meet those of the scale, they are shorter and deeper than those leaf epidermal cells touching the larvæ, but they are much larger than the epidermal cells in the older parts of the leaf into which they insensibly merge (Fig. 6). These cells have less contents than those in contact with the larvæ, but more, again, than the normal leaf epidermal cells.

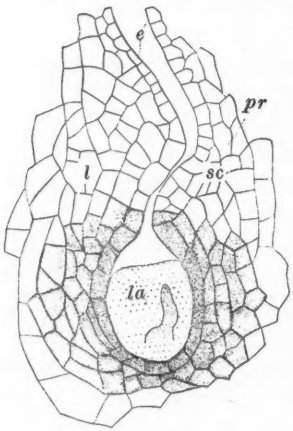

FIG. 6. — Longitudinal section through a cavity containing a young larva. The shaded area indicates the tissues with the densest cell contents (*la*, larva; *sc*, scale; *l*, leaf; *e*, epidermis; *pr*, parenchyma). April 25. × *circa* 56.

The epidermal cells on the inner surface of normal scales are long, shallow, and thin-walled ; the epidermis on the outer surface

varies only in the character of the outer cell wall, which, in this case, is thickened and strengthened by transverse ridges. On the inner surface and near the base of the scales the epidermal cells are shorter and resemble those of the leaf at a corresponding distance from the axis. The epidermal cells of the scales have very little contents.

In the galled leaves the scale epidermis lining the cavity in which the larvæ lie consists of long, thin-walled cells, which in size, shape, and density of contents resemble those epidermal cells of the leaf that line the other part of the cavity. The scale epidermal cells are shorter and deeper above the larvæ where the epidermis of the scale and of the leaf meet, and they gradually change into the normal form, somewhat above the neck of the larval cavity (Fig. 6).

It is thus seen that, in consequence of the presence of the parasite, the epidermis of scale and leaf is modified in shape and size, in structure, in contents, and in function.

A cross-section of the base of a galled leaf bundle, made from one of the same age as that represented in the longitudinal section in Fig. 6, shows that the tissue adjacent to the cavities containing larvæ is mainly parenchymatous, *i.e.*, the cells that compose it are relatively large and thin-walled, and are those cells which, in plants, are most sensitive to stimuli.

The tissue of the scale base is composed of large, rounded cells, between which are many intercellular spaces. These cells have but little contents. Near the juncture of scale base and leaf the cells are some of them larger and some smaller, and there are fewer intercellular spaces. In the axil of scale and leaf the cells are normally much smaller than any met with in the scale. Finally, the tissue surrounding the rudimentary conducting tissue, which in galled leaves abuts on the inside of the cavity containing the larvæ, is composed of small cells of the kind just described as occurring in the scale base. The thin-walled mesophyll cells of the leaf normally are differentiated into quite another tissue; as the leaf becomes older these cells become oblong, thick-walled, supporting cells (sclerenchyma) of the mature pine leaf. The cells of the tissues described have but little contents.

The parenchymatous tissue of the scale and leaf which is in contact with the epidermis of the cavity containing larvæ, for two or three cells from the cavity, follows the shape, size, and appearance of the epidermal cells (Fig. 6). Beyond these layers of parenchyma the cells become larger than in normal corresponding tissue, and gradually merge into the tissues of the scale on the one hand, and of the leaf on the other. These cells for six or eight layers around the cavity are filled with granular matter that increases in density toward the cavity.

The parenchymatous tissues which surround the parasite are affected in a negative manner as well. They are prevented from being differentiated and from developing as do their fellows under normal conditions. The scales in the normal leaf bundle turn brown early and die. They form the cup which surrounds the bases of the three leaves, or "needles," and which persists during the period of the normal leaf's activity. In the scales of the galled bundle the parenchymatous tissues remain active until early autumn, or during the activity of the parasite. Those cells of the leaf inside the region of the cavities containing larvæ, as has been stated, become in normal leaves thick-walled supporting tissue. In galled leaves they become, when fully developed, as large as the underlying parenchyma, and their walls in thickness reach a condition intermediate between the thick-walled supporting tissue, or sclerenchyma, and the parenchyma.

It is to the change in form and size of the cells which surround the cavity containing larvæ that the hypertrophy is due.

In July the condition of the galled leaf bundles of the Monterey pine differs only in degree from that just described as their condition in April. The parenchymatous cells are somewhat larger, the epidermis of the cavity containing larvæ, and all of the cells in the adjacent tissues of the scale and leaf, are active in providing food for the growing larvæ.

III.

We come now to the question, What is the immediate cause of the hypertrophy? And to this only an imperfect, and perhaps

unsatisfactory, answer can be given. And this must be based on the all too slight evidence which lies before us.

There is no indication that the hypertrophy is either caused or affected by any substance deposited with the eggs.

Extensive experimentation would be necessary to prove what the effect would be of a foreign body, living or lifeless, in contact with such plant tissues; or, again, how much the waste matter given off from a living body would affect the tissues. There is some evidence, although negative, touching the former in the cases cited above, where the eggs of the gallfly were placed either between the scales or between the inside scale and near the tip of the leaf. In neither of these cases did the larvæ mature, and the reason for this must be that the cells which touched the young larvæ were not such as could easily give up their contents to nourish the parasite. In either case, however, they hatched into larvæ, and we may believe that, although no food may have passed from the cells of the host to the parasite, yet the plant tissues may have been mechanically irritated by the mere presence of a living foreign body. That the leaf epidermis was thickened would appear to make no difference if the plant tissues in question were stimulated to abnormal growth, mostly by this mechanical irritation, because cases are not wanting among plants[1] in which epidermal cells, although strongly cutinized, have been rejuvenated and have been caused to perform functions other than normal, or at least usual, and this, too, mainly from external mechanical stimulation. It is highly probable that the mere presence of the parasite does, to some extent, in the case of this gall, as in others, stimulate the living plant tissues.

Briefly it appears that the immediate and principal cause of the hypertrophy is the response on the part of certain plant tissues to the parasite's demand for food. This is indicated mainly by the gradual enlargement of the cells surrounding the parasite, in a manner which corresponds to its growth, and also by the unusual amount of food material which these cells contain.

[1] Peirce, G. J. On the Structure of the Haustoria of Some Phanerogamic Parasites, *Annals of Botany*, vol. vii (1893), No. 27, p. 295.

IV.

I have been asked, why does not this gall attack other species of pine? and it may be said that one other species, of half a dozen that were examined which are growing in the Stanford University arboretum (*Pinus attenuata*), has a few galled leaf bundles. The young shoot of this pine is, early in the growing season, similar in structure and size to that of the Monterey pine, but the leaves of *P. attenuata* do not remain the right length for being visited by the gallfly long enough to be seriously injured by it. The other species of pine do not develop their shoots at the right time, or the shoots are covered with resin, or they are otherwise unfitted either by size or by structure to be galled. The opinion may be ventured that the conditions for the proper laying of the eggs and those governing the life of the larvæ are so delicate and exacting that other species of our pines are not likely to suffer from the parasite.

The materials for this paper were collected in the spring and summer of 1898, from galled Monterey pines which were growing in the university arboretum.

LELAND STANFORD UNIVERSITY,
PALO ALTO, CAL.

NOTE ON DISTOMUM ARCANUM (N. SP.) IN AMERICAN FROGS.

W. S. NICKERSON.

In frogs used for laboratory dissection I have observed, in many cases, cysts forming considerable swellings just at the pylorus. These, when opened, are found to contain small distomes, together with a mass of friable material, which under the microscope is seen to consist in part of eggs and in part of a finely granular stainable substance whose source I have not determined. The worms, though closely resembling several species which inhabit the intestines of European frogs, seem nevertheless to be distinct from them morphologically, and have, I believe, not been mentioned heretofore. I shall describe them under the name *Distomum arcanum*, the specific name referring to their being concealed from view in the cyst. So far as observed, the cysts occur always, when present, just at the pylorus, where they form conspicuous rounded swellings, about three millimeters in diameter. In extreme cases of infection as many as four or five of these may be present in the same frog. Two worms are usually present in a cyst. The wall of the cyst is composed of fibrous tissue and smooth muscle, which completely surround and enclose the contents. Several series of sections of cysts and contents have failed to show any indication of a connection between the cavity of the cyst and the lumen of the intestine. The accumulation of so large a mass of eggs and other material within the cyst tends further to disprove the existence of an opening from the cyst. The sexually mature worms have been completely imprisoned by their host.

The preserved specimens are small, stout, ovoidal, or spheroidal worms, the largest measuring 2½ × 1¾ mm., and the average size being about 1½ × 1¼ mm. The rather small suckers are of nearly equal size, the oral being slightly larger than the ventral. The latter, which is rather feebly developed,

is about two-thirds the length of the animal from the anterior end. The surface of the body is thickly set with minute scales or spines, which diminish in size toward the posterior extremity. The sexual orifice is near the left side, ventral, rather nearer to the oral than to the ventral sucker. The excretory pore is dorsal, nearly terminal, median, surrounded by a small cluster of gland cells.

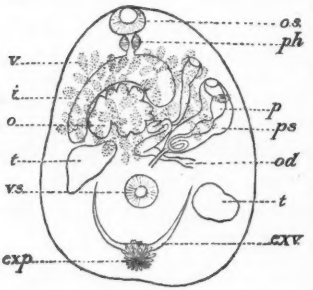

FIG. 1. — Outline drawing of *D. arcanum*, showing positions of chief organs as seen from ventral side. Uterus (except terminal portion) not represented. Camera outline × 38. *exp*, excretory pore; *exv*, excretory vesicle; *i*, intestine; *o*, ovary; *od*, oviduct (terminal portion); *o.s.*, oral sucker; *p*, penis; *ph*, pharynx; *ps*, penis sac; *t*, testis; *v*, vitellary glands; *vs*, ventral sucker.

The pharynx is small and placed immediately behind the oral sucker, and is followed at once by the bifurcation of the intestine. The limbs of the intestine are short and sac-like, extending backward, not farther than the middle of the body. The walls are thin and feebly developed.

The ovary is irregular in form or lobulated, and is situated just behind the forking of the intestine, a little to the right of the median line. Vitellary glands lying nearer the ventral surface are irregularly distributed through a zone extending from about opposite the pharynx back nearly to the ventral sucker. They appear as small cell-clusters or masses having a loosely dendritic arrangement.

The region of the union of the oviduct with the ducts from the vitellary glands and of the giving off of Laurer's canal is in the central portion of the body, just back of the ovary and nearer the dorsal surface, but the exact arrangement of these tubules I have not made out. The shell gland is readily seen in sections but not usually evident in entire preparations. Laurer's canal opens on the dorsal surface posterior to the ovary, nearly over the ventral sucker. The oviduct or uterus fills the greater portion of the space remaining between and around the other internal organs, but its folds appear to lack any definiteness of arrangement.

There are two testes, somewhat elongated or of slightly irregular outlines, situated one upon either side of the body, about in line transversely with the ventral sucker. The penis sac is a prominent organ at the left of the ovary and having a length of about one-fourth the length of the worm. It has thick muscular walls within which the retracted penis lies coiled.

The vagina, or terminal portion of the oviduct, opens immediately beside the opening from the penis sac and in front of it. The two openings appear in many specimens as separate apertures upon the surface of the body; in others they open into a common groove or depression of the body wall or genital atrium.

The eggs are elliptical or very slightly ovoidal in outline, measuring about 23 × 13 μ. The line of separation of the lid is usually not evident.

The excretory vesicle forks just in front of the excretory pore, forming two tubules which diverge as they extend forward near the testes, beyond which I have not traced them.

It will be seen from the foregoing description that *D. arcanum* is closely related to several species which it resembles in its small size, compact form, spiny covering, rudimentary intestine, and laterally placed sexual aperture, as well as in being parasitic in the intestine of the frog. *D. medians* is the form which it resembles most closely, the two species being essentially alike in many respects. *D. medians* has, however, a regular rounded ovary, situated on the right side, while, as already stated, the ovary in *D. arcanum* is lobulated and nearly median in position. The latter species appears also to be a little smaller and less elongated. The vitellaria, also, are distributed over a zone whose breadth is about one-half the length of the worm, while *D. medians* has the vitellaria restricted to the anterior quarter of the animal. Measurements of the eggs of the two species show that they also differ in size. There is further to be taken into account the fact that *D. medians* lives free in the intestine in (European) frogs, while *D. arcanum* is found completely enclosed within cysts at the pylorus of

SMALL DISTOMES WITH LATERALLY PLACED GONOPHORE (LEFT) AND SPINY COVERING.[1]

	OVARY.	TESTES.	INTESTINE.	SUCKERS.	SIZE, MM.	OVA, μ.	OCCURRENCE.
D. clavigerum Rud.	rounded, on right side, near ventral sucker	in hinder part of body	forks long	oral larger, 3 : 2 (2 : 1)	– 3.3 long	33 × 16	intestine of frogs, etc. (European)
D. medians Olsson	round or oval, on right side, opposite fork of intestine	laterally placed in line with ventral sucker	forks reach middle of body	oral larger, 14 : 11	2 × 1	30 × 16	intestine of frogs and toads from pylorus to midway of intestine (European)
D. confusum Looss	rounded, median, in front of ventral sucker	near anterior end, in line with pharynx, one on each side	forks short	oral little larger, 16 : 15	1.36 × 1	34 × 13	intestine of frog, etc., at pylorus, not back of opening of gall duct (European)
D. arcanum n. sp.	lobulated, nearly median, just back of fork of intestine	laterally placed in line with ventral sucker	forks short, not reaching beyond middle of body	oral little larger	1.5 × 1.25 (largest 2 × 1½)	23 × 13	in cysts at pylorus of frogs (American)

[1] The descriptions of the three European species are as given by Looss (1894), *Die Distomen unserer Fische und Frösche.*

(American) frogs. In view of these differences there can, I think, be no question that the two forms are distinct species.

From *D. clavigerum* it differs in being smaller and less elongated and in having short limbs to the intestine, while in that form the limbs of the intestine reach nearly to the posterior end of the body.

It is readily distinguished from *D. confusum* by the fact that the latter form has the testes far forward, alongside of the pharynx. The resemblances and differences of these four forms may be best shown perhaps by the tabular statement on the opposite page of their chief characteristics.

I have collected about fifty specimens of *D. arcanum*, all from frogs dissected in Massachusetts. I have not found them in western frogs. No record was kept of the species of frogs from which specimens were taken, and I have, therefore, no means of judging whether it occurs in all the different species or only in particular ones. The specimens collected were taken from frogs used for laboratory dissection, the greater number being the larger common species, except the bullfrog (*R. catesbiana*).

I had hoped to supplement these observations, made mostly several years ago and in large part upon preserved specimens, by the study of other living worms; but, as such specimens are not to be obtained in Minnesota, it seems best to publish such notes as I have without further waiting.

UNIVERSITY OF MINNESOTA,
July 17, 1900.

INSTINCT OR REASON?

G. W. AND E. G. PECKHAM.

IN our work on the instincts of solitary wasps[1] we included among the true instincts the way in which the wasp acts after bringing her prey to the nest, and gave as an example the habit of *Sphex ichneumonea* in placing her grasshopper at the entrance to the tunnel and then running in and out again before dragging it down. We also referred to the experiment of Fabre on a Sphex, in which he took advantage of the moment that the wasp was out of sight below to move her prey to a little distance, with the result that when the wasp came up, she brought her cricket to the same spot and left it as before, while she visited the interior of the nest. Since he repeated this experiment about forty times, and always with the same result, it seemed fair to draw the conclusion that nothing less than the performance of a certain series of acts in a certain order would satisfy her impulse. She must place her prey just so close to the doorway; she must then descend and examine the nest, and after that must at once drag it down, any disturbance of this routine causing her to refuse to proceed. We recently found a *Sphex ichneumonea* at work storing her nest, and thought it would be interesting to pursue Fabre's method and find out whether she were equally persistent in following her regular routine. We allowed her to carry in one grasshopper to establish her normal method of procedure, and found that, bringing it on the wing, she dropped it about six inches away, ran into the nest, out again, and over to the grasshopper, which she straddled and carried by the head to the entrance. She then ran down head first, turned around, came up, and, seizing it by the head, pulled it within. On the following day, when she had brought the grasshopper to the entrance of the nest, and while she was below, we moved it back five or six

[1] *Instincts and Habits of the Solitary Wasps*, p. 232, 1898.

inches. When she came out she carried it to the same spot and went down as before. We removed it again with the same result, and the performance was repeated a third and a fourth time; but the fifth time that she found her prey where we had placed it, she seized it by the head and, going backward, dragged it down into the nest without pausing. On the next day the experiment was repeated. After we had moved the grasshopper away four times, she straddled it and carried it down into the nest, going head foremost. On the fourth and last day of our experiment she replaced the grasshopper at the door of the nest and ran inside seven times, but then seized it and dragged it, going backward into the nest.

How shall this change in a long-established custom be explained except by saying that her reason led her to adapt herself to circumstances? She was enough of a conservative to prefer the old way, but was not such a slave to custom as to be unable to vary it.

EDITORIAL COMMENT.

Doubtful Economy. — That much of the work done by the United States through the Department of Agriculture and by the various State Commissions and Experiment Stations is of high practical importance has long been recognized both here and abroad.

Scientific men may, however, well hesitate before endorsing many of the recommendations advocated. The application of kerosene as a preventive against mosquitoes should be used only when other methods are not applicable. The destruction of herons, kingfishers, loons, grebes, and other birds, advised by the Superintendent of Hatcheries in the *Third Annual Report of the Commissioners of Fisheries, Game, and Forests of the State of New York*, shows the extreme to which practical science tends. These birds have a scientific value and interest equal at least to the gastronomic value of the trout they destroy, and the State of New York can better afford to establish a hatchery for the benefit of the bearers of fur and feathers than to countenance or allow their slaughter.

Frazer's Life of Cope. — The August issue of the *American Geologist* is devoted chiefly to a memoir by Dr. Persifor Frazer, entitled "The Life and Letters of Edward Drinker Cope." The life is told mainly by the letters; Dr. Frazer's threads connecting them are slight, and though appreciative are sadly lacking in the happy touches needed for the subject. The illustrations include an interesting portrait of Cope at ten years of age and several reproductions from pen-and-ink drawings made when their author was still a lad. The care and faithfulness shown in these drawings are remarkable, qualities not fully recognized by Dr, Frazer's comparative praise. Gill's admirable address delivered at the Detroit (1897) meeting of the American Association for the Advancement of Science is not mentioned in the list of biographies.

The Biological Bulletin. — From the programme of the Biological Departments of the University of Chicago, 1900–1901 (p. 4), it would appear that the publications of the University included both

the *Bulletin* and the *Journal of Morphology*, and also that contributions were limited to zoölogy and general biology. It may be well to note that the *Biological Bulletin* is still published under the auspices of the Marine Biological Laboratory, and is open to botanical as well as zoölogical papers.

REVIEWS OF RECENT LITERATURE.

PSYCHOLOGY.

Individual Psychophysiology of the Crayfish. — In what sense, if at all, may the term "individuality" be applied to the crayfish? is the question which Dr. Dearborn[1] has attempted to answer experimentally.

Starting with the definition, "a living organism is an individual in proportion to the relative constancy and strength of its own proper tendencies considered as manifestations of an inherent will," the writer, by studying the individual reactions of about twenty representatives of *Cambarus affinis*, arrives at the conclusion that there is no evidence of psychic individuality.

The experiments upon which this conclusion rests are: 1. The determination of traction strength, or the pulling power of the animal. The traction power per gram of body weight varies from 1.7 to 3.5. Three tests were made for each individual on different days, and great variation is noticeable. 2. The pinching power of the chelæ. 3. Returning habits; the crayfish being placed on its back on a *glass plate* and *allowed to right itself if possible.* In this, too, there is remarkable variability. It is an interesting and suggestive experiment, by the future use of which much should be learned concerning the mechanism of the crayfish. 4. Training in the returning habit. Training was given in a particular method of returning, but with negative results. 5. Reactions to galvanism. 6. Galvanotropism. The animals invariably go to the cathode, although at widely differing rates. 7. Hypnosis. Crayfish are easily hypnotized by holding them firmly in a stable position for a short time. Dr. Dearborn emphasizes the fact that the time necessary for hypnosis varies greatly in different animals and in the same animal from time to time, as does also the duration of the hypnotic influence. He differs from Verworn in holding the process of hypnosis in the crayfish to be the same as human hypnosis. 8. Reaction time. The reaction of the forceps of the chelæ to tapping on some part of the shell (the

[1] Dearborn, G. V. N. Notes on the Individual Psychophysiology of the Crayfish, *Amer. Journ. of Physiol.*, vol. iii, No. 9 (1900), pp. 404–433.

place of stimulation is indifferent, the writer states) was determined for ten animals, and found to vary from .20 second to .65.

A comparative study of the results of these experiments "fails to discover anything . . . so far comparable to individual temperaments" as "sensitive and weak" or "dull and strong." "Absence of correlations and inconstancy are the two significant features of the results."

The value of this work, it would seem, lies chiefly in its suggestiveness. Almost every page of the report points out some line of work which might claim months of careful study. Much of the evidence furnished by the experiments seems to us inconclusive because of an insufficient number of observations. Dr. Dearborn has, by the use of the "extensive" method, exposed himself to the criticism "fragmentary and superficial."

R. M. Y.

The Problem of Innate Ideas. — The third of Dr. Ad. Wagner's *Studien und Skizzen aus Naturwissenschaft und Philosophie*[1] is a philosophic discussion of "innate ideas." Of the two earlier papers of this series the first dealt with scientific thought and popular science, the second with the problem of free will.

Dr. Wagner calls attention to the far too common avoidance of fundamental problems by natural scientists . . . "der Naturgelehrte meistens sagen: Ach was! Ich bin Naturforscher. Lasst mich mit Eueren philosophischen Problemen in Ruhe! Die gehen mich nichts an."

In this short essay the nature of knowledge is very clearly and concisely treated. In many respects Wagner's standpoint is Kantian. He considers space, time, and causation "forms" of thought. The latter part of the paper is devoted to the relations of the brain as the organ of mind to the "*a priori*" (commonly so-called) of knowledge.

R. M. Y.

Empirical Teleology.[2] — It seems unfortunate that Cossmann should have chosen a title so unattractive to the majority of biologists as "Elements of Empirical Teleology," for there is much in his book worthy of their attention.

[1] *Ueber das Problem der angeborenen (apriorischen) Vorstellungen.* Berlin, Gebrüder Borntraeger, 1900. 77 pp.

[2] Cossmann, Paul Nikolaus. *Elemente der empirischen Teleologie.* Stuttgart, A. Zimmer, 1899. 132 pp.

The work consists of two parts, of which the first treats of the teleological laws of nature, and the second of the methods for the investigation of these laws.

Necessary connections or natural laws the author finds to be the objects of science. Empirical science, and especially the scientific concept of cause, is discussed to some extent, but by far the greater part of the book is devoted to what might be termed the philosophy of biology.

Causality, having been defined in terms of general empirical science, and also of special biological science, the biological concepts of living, organic, etc., are analyzed in an interesting fashion.

Under methods of investigation the possibility of methodical work in the teleological sphere is discussed in connection with the standard methods: induction and deduction.

R. M. Y.

ZOÖLOGY.

The Effect of the Staleness of the Sex-Cells upon Development and upon the formation of hybrids has been reinvestigated by Dr. H. M. Vernon.[1] He finds in the case of the echinoderms that the number of normal blastulæ formed from sex-cells kept for some time in sea water diminishes about one per cent per hour up to the twenty-seventh hour, after which time abnormalities rapidly increase in number. Within this period the same decrease was noted whether either or both of the sexual products were stale, but after the twenty-seventh hour the decrease in normal embryos was most rapid when both of the sex-cells were in this condition. The larvæ obtained from stale sex-cells were of the normal size, though when the sperm alone was stale they were often larger, and when the ovum was stale they were smaller, than those derived from fresh products. Contrary to the conclusion of the Hertwigs, staleness of the ova in hybrids of Sphærechinus ♀ × Strongylocentrotus ♂ did not increase the number of hybrid plutei, though in the reciprocal cross a larger percentage of blastulæ was produced. The hybrid larvæ obtained on crossing Sphærechinus ova with Strongylocentrotus spermatozoa vary

[1] Vernon, H. M. The Effect of Staleness of the Sexual Cells on the Development of Echinoids, *Proc. Roy. Soc.*, vol. lxv (1899), pp. 350–360.

Vernon, H. M. Cross Fertilization among Echinoids, *Arch. f. Entwickelungsmechanik der Organismen*, Bd. ix (1900), pp. 464–478.

in type at different seasons of the year. In the summer, when the sexual products of the latter are at a minimum of maturity, the hybrids show a greater resemblance to pure Sphærechinus plutei than do those obtained in the spring. C. A. K.

Protozoan Studies. — The continuation of Dr. Prowazek's[1] work upon the Protozoa contains his observations on many species and discussions of many protozoan problems for whose solution the fragmentary evidence offered, though important in its bearings, is often insufficient. The reproduction of the Rhizopoda is illustrated by stages in the copulation of Euglypha and Trinema, and by sporulation in the autumn months in the same genera and also in Nebela, though no relation between the two processes was detected. These genera are frequently parasitized by *Achromatium oxaliferum*, and in this condition superficially resemble stages in sporulation. Autotomy was observed in Amœba and in Nebela, the rejected portion of the body usually containing the detritus from food vacuoles. From many observations on different species the author concludes that the formation of pseudopodia is always initiated by the ectoplasm. The structure and movements of flagella and of cilia are discussed and the inclusions in protoplasm are described and classified. Six types of non-living inclusions are recognized: (*a*) the Microgranula, composed of minute particles, the products of metabolism, found principally near the vacuoles and the ectoplasm; (*b*) the Hyalogranula, derived from the first and composed of transparent, bluish-green, somewhat refractive, elongate or flattened granules which are abundant near the vacuoles in the endoplasm and are also frequently found on cysts and in gametes; (*c*) the Lamprogranula, consisting of yellowish or greenish, spherical or oval, highly refractive bodies apparently enclosed in vacuoles and usually exhibiting Brownian movements; (*d*) excretory inclusions of spherical form, often with concentric structure and central cavity; (*e*) excretory crystals of various types; (*f*) the Leucogranula, composed of colorless, slightly refractive granules in the ectoplasm of Stentor and some other ciliates.

A sessile heliozoan of unique form and habitus, *Myxodiscus crystalligera*, is described from a marine aquarium. Sessile life has induced a polar differentiation, the pseudopodia being confined to the free surface. Its food consists of ciliates. *Phacodinium muscorum*, a new ciliate, is described from damp woodland moss. C. A. K.

[1] Prowazek, S. Protozoenstudien, II, *Arb. zool. Inst. Wien*, Bd. xii (1900), 58 pp., 2 pls.

The Aleurodidæ. — The insects so named constitute a family of Homoptera, allied to the Coccidæ, but having four wings in the adults of both sexes. Two genera are recognized, Aleurodes and Aleurodicus. We have before us the first attempt at a revision of the American members of this family, written by Professor A. L. Quaintance of the Georgia Experiment Station.[1] All the species of North and South America, so far as yet recognized in the literature, are enumerated, and many new species are described. Although the group is quite numerous in species, some of which are decidedly of economic importance, it has been strangely ignored in the past by American entomologists. Only the following species were described previous to 1880: *Aleurodes phalænoides* Blanchard, 1840 (not now recognized), *A. cocois* Curtis, 1846 (now referred to Aleurodicus), *A. abutilonea* Haldeman, 1850, *A. corni* Haldeman, 1850, *A. asarumis* Shimer, 1867 (now referred to Aleurodicus). At the present time Professor Quaintance is able to list forty-two species of Aleurodes and ten of Aleurodicus. All the species of the latter genus are tropical or subtropical, except *A. asarumis* from Mt. Carroll, Ill. This last is not now known to exist in collections, and is placed in Aleurodicus because Shimer says the central vein branches. It seems just possible to the writer that it is an Aleurodes, as some species of that genus appear to have the branching vein of Aleurodicus, owing to the presence of a deceptive fold. Altogether the work is a very valuable and timely one, and it is to be hoped that it will further the study of the Aleurodidæ, which it renders comparatively easy. It is, unfortunately, rather marred by numerous misprints.

T. D. A. Cockerell.

Scientific Results of H. M. S. "Thetis."[2] — The second part of the "Scientific Results of the Trawling Expedition of *H. M. S.* 'Thetis' off the Coast of New South Wales" is devoted to the higher Crustacea, by Mr. Thomas Whitelegge, zoölogist of the Australian Museum. As evidence of the richness of the fauna about Port Jackson, the author enumerates sixty-five species of invertebrates attached to or living upon a rock of about thirty pounds in weight, which was

[1] *Bulletin No. 8* (1900), Technical Series, Division of Entomology, Department of Agriculture, pp. 9–64.

[2] Scientific Results of the Trawling Expedition of *H. M. S. Thetis* off the Coast of New South Wales, etc., Pt. II. The Crustacea, Pt. i, by Thos. Whitelegge, *Mem. Australian Museum*, vol. iv, pp. 135–199, Pls. XXXII–XXXV. Sydney, 1900.

fished from a depth of thirty fathoms. After this preliminary we are prepared for the statement that the *Thetis* in its search for fishes obtained incidentally forty-nine species of Decapoda and Stomatopoda, of which twenty-one are additions to the fauna and ten are new. These last are *Pugettia mosaica*, *Chlorinoides waitei*, *Paramithrax tuberculatus*, *Pilumnus australis*, *Paguristes tuberculatus*, *Sympagurus diogenes*, *Glaucothoë hexagonata*, *Porcellano-pagurus tridentatus*, *Galathea* (*sp.* ?), and *Arctus crenatus*. The new species, as well as some of the old ones, are fully described, and illustrated by photographs and outline drawings. Among the most notable of the other additions to the fauna is *Pseudosquilla stylifera* (Milne-Edwards), which was known only from Chile and southern California. This species, by the way, is entitled to a new name, being different from *Squilla stylifera* of Lamarck, which Dr. Bigelow considers synonymous with *Pseudosquilla ciliata* (Fabricius?) Miers. It is perhaps not remarkable that generic names that have been accepted for fifty or a hundred years, like Arctus, Eupagurus, and Squilla, should still be adhered to, though proven untenable.

The Temple Primers, which are intended to give condensed information on great subjects, open with a volume on Some Problems of the Day in Natural Science: An Introduction.[1] About half the book is given to first principles, including the definition, aim, and boundaries of science, the relations of science to philosophy, the senses as agents of the mind and their extension by artificial aids, the classification of the sciences, and the history and method of science. The remainder of the book is devoted to certain scientific problems of the day, such as the age of the earth, the ultimate constitution of matter, the origin of species, the coagulation of the blood, the function of nerve cells, and microphytology. In such restricted space so many problems can be touched on only superficially, and herein lies the chief defect of the volume. The book is neither better nor worse than its kind, but one is forced to ask why the impossible should be attempted.

P.

The Biological Bulletin. — Two issues of the *Biological Bulletin* were received in August. Vol. I, No. 4, dated July, 1900, contains: "Our North American Echiurids," by Charles B. Wilson; "Some General Features of the Metamorphosis of the Flag Weevil,

[1] Hill, Alexander. *The Temple Primers.* I. An Introduction to Science. London, Dent & Co., 1900. viii + 140 pp.

Mononychus vulpeculus Fabr.," by James G. Needham ; "Notes on the Physiology of Regeneration of Parts in Planaria maculata," by C. C. Lemon ; and "The Structure of the Eye of Scutigera (Cermatia) forceps," by Josephine Hemenway. Miss Hemenway does not refer to Packard's paper on the eye of *S. forceps*, and errs in stating that there is but one American Scutigera ; other species have been described by Wood, Meinert, and Bollman.

No. 5, August, 1900, contains : "Abnormalities in the Cestode Moniezia expansa, I," by C. M. Child ; and "A Description of the Male of Peripatus Eisenii Wheeler," by Augusta Rücker. Miss Rücker's paper is No. 5 of the *Contributions from the Zoölogical Laboratory of the University of Texas*, a series that already proves the wisdom of the university authorities in their choice of a director.

Notes. — The discovery of Moringuoid eels in American waters, by Dr. T. N. Gill and H. M. Smith (*Science*, Vol. XI, p. 973), is a matter of considerable interest. They find that the group is represented in the American tropics by four genera : Moringua, Aphthalmichthys, Leptoconger, and Gordiichthys.

Parts I–II, Vol. XXIII, of *Termeszetrajzi Füzetek* contain many papers of entomological interest. Among these mention may be made of Förster's "Odonaten aus New-Guinea, Part II," "Les espèces du genre Troides appartenant aux collections du Musée National Hongrois," by Horvath et Mocsáry, with three magnificent plates, and a "Catalogus Tabanidarum orbis terrarum universi," by Dr. Colomannus Kertész.

The giant hydroid *Brachiocerianthus* (*Monocaulus*) *imperator*, described by Allman from the *Challenger* collections, has again been taken in Japanese waters and minutely described by Miyajima (*Journ. Col. Sci. Imp. Univ. Tokyo*, XIII, Pt. II). In the long discussion and comparison with Mark's *B. urceolus* the reader is led to infer that the latter is also a Japanese species instead of being a tropical form from the extreme eastern Pacific. No indication is given as to the habitat, nor that it was taken by the Agassiz "Albatross" expedition of 1891 in the Panama district.

No. 4 of the fifth volume of the *American Journal of Physiology* contains the following articles : "On Uric Acid Formation after Splenectomy," by L. B. Mendel and H. C. Jackson ; "On the Phosphorus Content of the Paranuclein from Casein," by H. C. Jackson ; "Further Experiments on Artificial Parthenogenesis and the Nature

of the Process of Fertilization," by J. Loeb; and "Mammalian Smooth Muscle: The Cat's Bladder," by C. C. Stewart.

The concluding number of Vol. XVI of the *Journal of Morphology* contains: "The Development of the Coxal Gland, Branchial Cartilages, and Genital Ducts of Limulus polyphemus," by W. Patten and A. P. Hazen; "The Embryology of a Termite," by H. McE. Knower; "The Gastrulation of Amphioxus," by T. H. Morgan and A. P. Hazen; and "Photographs of the Egg of Allolobophora Fœtida," by K. Foot and E. C. Strobell.

BOTANY.

Text-Book of Botany.[1] — A copiously illustrated text-book of botany has been issued recently from the press of Baillière & Co., under the editorship of Felix Alcan, the object of which appears to be to supply a work of reference for university students, to which purpose it is well adapted. The treatment of the subject is logical and thorough, and generally in accord with the most recently ascertained facts, although adherence to an obsolete classification detracts somewhat from its usefulness. Under ten separate parts, the work presents a comprehensive view of plant life in all its phases, and discusses the place which plants occupy in nature. These are, respectively: (1) The Structure, Properties, and Products of the Body in general; (2) The Tissues; (3) The Structure of Members; (4) Growth of the Plant; (5) Nutrition; (6) Plant Associations — Symbiosis; (7) Movement; (8) Reproduction and Development; (9) Structure and Development of Cryptogamic Plants; (10) Ferments.

It is especially gratifying to find a recent work which takes a comprehensive view of the entire subject, and the chapters on Ferments and Plant Associations will be found particularly acceptable to students who wish to study these subjects in their proper relations to the general phenomena of plant life.

D. P. P.

Notes. — An expected upheaval of generic and higher botanical names begins in the June number of the *Allgemeine Botanische*

[1] Bebzung, Er. *Anatomie et Physiologie Végétales.* Paris, Baillière, 1900. 8vo, 1303 pp., 1700 figs.

Zeitschrift, with the first of a series of papers by Kuntze and von Post, and promises to be far-reaching if not final.

In *Science* for July 13, Dr. C. A. White contends for the use of the terms "epitropism," "apotropism," "hypercotyl," and "hypernasty," in place of the words "geotropism," "apogeotropism," "epicotyl," and "epinasty," now in common use.

Mr. Gannett's excellent paper on "The Forests of the United States" is separately published from the *Twentieth Annual Report of the United States Geological Survey.*

The flora of Ohio receives important consideration by Professor and Mrs. Kellerman in *University Bulletins* 27 and 28 of the botanical series of the Ohio State University.

C. A. Purpus is giving an account of the succulents of the La Salle Mountains of Utah, in current numbers of the *Monatsschrift für Kakteenkunde.*

An anatomical study of variegated leaves, by Mlle. Rodrigue, constitutes the greater part of No. 17 of the *Mémoires de l'herbier Boissier.*

Bulletin 107 of the Alabama Agricultural Experiment Station, devoted to cotton, contains, among other matters, chapters on the varieties of cotton, its improvement by hybridization and by selection, and its diseases, with a list of fungi recorded as growing on it, and a bibliography of its diseases.

The Rocky Mountain *Robinia neo-mexicana* is figured in *Curtis's Botanical Magazine* for July.

Bryophyllum crenatum, of Madagascar, a species related to the well-known life-plant, is figured in the *Revue Horticole* for July.

Mamillaria vivipara is figured in *Curtis's Botanical Magazine* for June.

Professor von Wettstein is publishing a study of certain North American gentians in current numbers of *Oesterreichische Botanische Zeitschrift.*

The well-known poisonous properties of *Primula obconica* form the subject of an article by Nestler in Heft V of the current volume of *Berichte der deutschen botanischen Gesellschaft.*

Helenium tenuifolium is figured in *Curtis's Botanical Magazine* for June.

Hesperaloe yuccæfolia, in the form which has been called *H. Engelmanni*, is figured in *Curtis's Botanical Magazine* for July.

A well-illustrated revision of the species of Bromus occurring north of Mexico, by C. L. Shear, is published as *Bulletin* No. 23 of the Division of Agrostology of the United States Department of Agriculture.

The folklore and history of the yew form the subject of a series of articles in the current numbers of *Prometheus*.

Professor Bessey contributes a revision of the tribes and a rearrangement of the genera of North American Diatomaceæ to Vol. XXI of the *Transactions of the American Microscopical Society*.

The dedication of Vol. LVII of *The Garden* is to Sir William Turner Thiselton-Dyer, and is accompanied by a short biographic sketch and an excellent portrait of the director of the celebrated Kew Gardens.

A portrait of Franchet accompanies Nos. 4 and 5 of the *Bulletin de la Société botanique de France* of the current year.

A portrait of the late Professor D. C. Eaton forms the frontispiece of the July number of *The Fern Bulletin*.

PALEONTOLOGY.

Fossil Cephalopods in the Timan. — Professor Holzapfel's[1] work should be read in connection with a recent memoir by Dr. J. M. Clarke ("Naples Fauna," *Ann. Rep. N. Y. State Geol.*, 1898), on the Intumescens fauna in America. In Dr. Clarke's work we see the fauna after it had immigrated to American waters, and in Professor Holzapfel's we see the fauna nearer to its origin. In New York the genus Manticoceras seems to be the prevailing one; in the Timan Gephyroceras is preëminent, while it is lacking in New York, but represented by Probeloceras Clarke. Those forms assigned by Clarke to Gephyroceras seem to agree with Timanites. The Intumescens fauna of the Timan agrees closely with that of the Urals, a number of species being identical.

[1] Holzapfel, E. Die Cephalopoden des Domanik im südlichen Timan, *Mém. Comité Géol.* (*Russie*), T. xii (1899), No. 3.

The New York fauna also shows a difference in the earlier appearance of Clymenia, which had not yet reached European waters.

Genuine Prolecanites occur in the Timan beds, but appeared later in America, in the Chemung, and became common first in the Kinderhook. An important note in Dr. Holzapfel's paper is that Karpinsky's genus Ibergiceras (*Gon. Tetragonus* Rœmer), which has been supposed to be the radicle of the Prolecanitidæ, is merely the young of *Pronorites cyclolobus* and came from the Carboniferous limestone of Iberg, not from the Intumescens beds, as has been thought heretofore.

J. P. S.

Russian Carboniferous Cephalopods. — In this paper the author[1] has given another important contribution to our knowledge of the cephalopod faunas of the Russian Carboniferous limestone. What is most interesting to American stratigraphers is that in this small collection are recognized a number of characteristic American species, most of which belong to the St. Louis-Chester horizon. This strengthens the probability that the lower part of the Moscow limestone belongs to the Lower Carboniferous and is the equivalent of the Visé formation of western Europe.

It should be noted, however, that the range of these species seems to be different from that in America. Thus *Nautilus chesterensis* Meek and Worthen in America is confined to the St. Louis-Chester horizon, and in Russia ranges up into the Coal Measures. The same thing is true of *Temnocheilus spectabilis* Meek and Worthen. *Brancoceras rotatorium*, as described by Tzwetaew, is correct generically, but the species is more robust than *B. rotatorium* or *B. ixion*, its American equivalent. Also in western Europe and in America this type occurs only in the Tournaisian, or Kinderhook, which gives additional weight to the improbability of specific identity.

J. P. S.

[1] Tzwetaew, Marie. Nautiloidea et Ammonoidea du calcaire carbonifère, *Mém. Comité Géol.* (*Russie*), T. viii (1898), No. 4.

NEWS.

AFTER eighteen years of active work Professor J. C. Arthur resigns as editor of the *Botanical Gazette*, but will continue as one of the associate editors.

The fifth International Zoölogical Congress will be held in Berlin in 1901, under the presidency of Professor Karl Möbius.

Professor Carl Gegenbaur, of Heidelberg, has retired from active teaching.

Appointments: Dr. H. Ambronn, professor extraordinarius of botany in the University of Jena. — Dr. Walter B. Cannon, instructor in physiology in Harvard Medical School. — Dr. Fridrano Carava, associate professor of botany in the University of Cagliari. — Dr. George V. N. Dearborn, assistant professor of physiology in Tufts College. — Professor Dr. J. V. Deichmüller, custodian of the mineralogical museum in Dresden. — Dr. P. Dinse, curator of the Museum of Oceanography at Berlin. — Dr. Geo. P. Dreyer, professor of physiology in the medical school of the University of Illinois. — Dr. Charles L. Edwards, professor of natural history in Trinity College, Hartford. — Dr. J. W. Folsom, instructor in entomology in the University of Illinois. — Dr. A. Fritsch, professor extraordinarius of botany in the University of Prag. — Dr. C. Gagel, regional geologist of Prussia. — Dr. Walter E. Garrey, of Chicago, professor of physiology in Cooper Medical College, San Francisco, Cal. — Frederick O. Grover, professor of botany in Oberlin College. — Professor Leon Guignard, director of the school of pharmacy in Paris. — Sir George F. Hampson, first class assistant in the British Museum, Natural History. — Miss A. P. Hazen, assistant in zoölogy in Smith College. — Dr. Janni, professor extraordinarius of mineralogy and geology in the University of Basel. — Dr. P. B. Kennedy, of Washington, associate professor of botany and horticulture in the University of Nevada. — Dr. Charles A. Kofoid, assistant professor of histology and embryology in the University of California. — Mr. Thomas Large, assistant in the Illinois State Laboratory of Natural History, in charge of ichthyology. — Mr. John H. McClellan, instructor in zoölogy in the University of Illinois. — Dr. Albert P. Matthews,

instructor in physiology in Harvard Medical School. — Dr. Alfred G. Mayer, curator of natural science in the museum of the Brooklyn Institute of Arts and Science. — Dr. M. Meissner, custos of the zoölogical section of the museum of natural history in Berlin. — Mr. E. W. Morse, instructor in natural history in Harvard College. — Professor H. F. Osborn, vertebrate paleontologist to the geological survey of Canada. — Edmund Perrier, director of the Natural History Museum at Paris. — Professor Ferdinand von Richthofen, director of the Museum of Oceanography at Berlin. — Dr. M. Siedlecki, privat docent for zoölogy in Cracow. — Miss F. C. Smith, assistant in botany in Smith College. — Dr. Julia W. Snow, instructor in botany in Rockford College, Illinois. — Dr. Hermann Triepel, prosector in the anatomical institute of the University at Greifswald. — Dr. Lewis G. Westgate, professor of geology in the Ohio Wesleyan University. — Dr. S. R. Williams, professor of zoölogy in Miami University, Oxford, Ohio. — Alexander N. Winchell, professor of zoölogy and mineralogy in the Montana School of Mines, Butte, Montana. — Dr. E. Zimmermann, royal Prussian geologist.

Deaths: E. Allard, coleopterologist at Paris, in April. — Dr. Henry Beauregard, professor of cryptogamic botany in the Paris School of Pharmacy, in April. — Dr. Gustav Born, professor of anatomy and director of the embryological section in the University of Breslau, July 5, of heart disease, aged 49. — J. Lucius Caflisch, president of the Swiss Entomological Society, at Chur, March 9. — Dr. Corrado Tomassi Crudeli, professor of pathological histology at Rome. — Dr. Paul Hagenmüller, conchologist, at Marseilles, June 8. — Professor E. Kernstock, lichenologist, in Klagenfurt, April 14, aged 48. — Dr. Karl von Kraatz-Koschlau, mineralogist and privat docent in the University of Halle, at Para, Brazil, in May, of yellow fever. — Professor W. Kühne, director of the physiological institute of the University of Heidelberg, June 11, aged 62. — Edgar Leopold Layard, ornithologist, at Budleigh Salterton, Devon, England, aged 75. He was well known for his *Birds of South Africa*. — Carl Johann Lindeberg, botanist, in Alingsas, Sweden, May 4, aged 85. — G. Sherrif Tye, conchologist, at Birmingham, England, February 4. — Walter Percy Sladen, well known for his studies of echinoderms, at Florence, Italy, June 11. — Percy S. Selous, naturalist, at Greenville, Mich., April 7, from the bite of a moccasin.

PUBLICATIONS RECEIVED.

(Regular exchanges are not included.)

ATKINSON, J. Winter Wheat. *Bull. Iowa Agr. Exp. Sta.*, No. 51. pp. 24–30. August. — BIOLETTI, F. T., and IAL PIAZ, A. M. Bench-Grafting Resistant Vines. *Bull. Cal. Agr. Exp. Sta.*, No. 127. p. 38, 9 figs. — BOGUE, E. E. An Annotated Catalogue of the Ferns and Flowering Plants of Oklahoma. *Bull. Okla. Agr. Exp. Sta.*, No. 45. p. 48. March. — BRANNER, J. C. Results of the Branner-Agassiz Expedition to Brazil. IV. Two Characteristic Geologic Sections on Northeast Coast of Brazil. *Proc. Wash. Acad. Sci.* Vol. ii, pp. 185–201, 9 figs. — BUFFUM, B. C. Alfalfa as a Fertilizer. *Bull. Wyo. Agr. Exp. Sta.*, No. 44. pp. 93–106, 3 figs. April. — BUFFUM, B. C. Alfalfa as a Hay Crop, etc. *Bull. Wyo. Agr. Exp. Sta.*, No. 43. pp. 47–91, 8 figs. March. — BUFFUM, B. C., and FAIRFIELD, W. H. Some Experiments with Subsoiling. *Bull. Wyo. Agr. Exp. Sta.*, No. 41. pp. 1–21, 2 figs. November, 1899. — COBB, J. N. The Sturgeon Fishery of the Delaware River and Bay. *Rept. U. S. Fish Com.*, 1899. pp. 369–380, plates 18–21. — EVERMANN, B. W. Descriptions of Two New Species of Darters from Lake Maxinkuchee. *Indiana Rept. U. S. Fish Com.*, 1899. pp. 363–367, plate 17. — FARR, MARCUS S. Check List of New York Birds. *Bull. N. Y. State Museum.* Vol. vii, No. 33, pp. 198–409. — FRAPS, G. S. The Digestibility of Some Non-Nitrogenous Constituents of Certain Feeding Stuffs. *Bull. North Carolina Agr. Exp. Sta.*, No. 172. pp. 49–80. May. — GILBERT, C. A. Results of the Branner-Agassiz Expedition to Brazil. III. The Fishes. *Proc. Wash. Acad. Sci.* Vol. ii, pp. 161–184. — HOWARD, L. O. Notes on the Mosquitoes of the United States, giving Some Account of their Structure and Biology, with Remarks on Remedies. *United States Department of Agriculture, Division Entomology. Bulletin No. 25.* p. 70, 22 figs. — JENKINS, O. P. Descriptions of New Species of Fishes from the Hawaiian Islands belonging to the Families Labridæ and Scaridæ. *Bull. U. S. Fish Com.*, 1899. pp. 45-65, 22 figs. — JENNINGS, H. S. Rotatoria of the United States with Special Reference to those of the Great Lakes. *Bull. U. S. Fish Com.*, 1899. pp. 67–104, plates 14–22. — MASSEY, W. F., and RHODES, A. Gardening under Glass. *Bull. North Carolina Agr. Exp. Sta.*, No. 170. pp. 1–24. March. — MILLER, G. S., Jr. Mammals collected by Dr. W. L. Abbott on Islands in the North China Sea. *Proc. Wash. Acad. Sci.* Vol. ii, pp. 203–246, 16 figs. — PALMER, T. S. Legislation for the Protection of Birds other than Game Birds. *United States Department of Agriculture, Division Biological Survey, Bulletin No. 12.* p. 94, 7 figs., 2 plates. — PALMER, T. S. A Review of Economic Ornithology in the United States. *Year-Book, Dept. of Agr. for 1899.* pp. 259–292, plates vi–viii. — RATHBUN, MARY J. Results of the Branner-Agassiz Expedition to Brazil. I. The Decapod and Stomatopod Crustacea. *Proc. Wash. Acad. Sci.* Vol. ii, pp. 133–156. — RICHARDSON, HARRIET. Results of the Branner-Agassiz Expedition to Brazil. II. The Isopod Crustacea. *Proc. Wash. Acad. Sci.* Vol. ii, pp. 157–159.

4 figs. — RITTER, WM. E. Papers from the Harriman Alaska Expedition. II. Harrimania Maculosa, a New Genus and Species of Enteropneusta from Alaska, with Special Regard to the Character of the Notochord. *Proc. Wash. Acad. Sci.* Vol. ii, pp. 111–132, plate vii. — SMITH, J. C. Notices of Some Undescribed Infusoria from the Infusorial Fauna of Louisiana. *Trans. Amer. Micr. Soc.* Vol. xxi, pp. 87–96, plate vi. — TOURNEY, J. W. Practical Tree Planting. *United States Department of Agriculture, Division of Forestry, Bulletin No. 27.* 4 plates, 2 figs. — WHEELER, H. J., and ADAMS, G. E. The Needs and Treatment of the Warwick Plain and other Sandy Soils of Rhode Island. *Bull. R. I. Agr. Exp. Sta.*, No. 68. pp. 159–174. June. — WHEELER, H. J., and BOSWORTH, A. W. Feeding and Feeding Stuffs. *Bull. R. I. Agr. Exp. Sta.*, No. 64. pp. 103–124. March. — WHEELER, H. J., and TILLINGHAST. Effect of Liming upon the Relative Yields and Durability of Grass and Weeds. *Bull. R. I. Agr. Exp. Sta.*, No. 66. pp. 137–147, 11 figs. April. — WHEELER, H. J., and TILLINGHAST. Fertilizer Experiments with Potatoes. *Bull. R. I. Agr. Exp. Sta.*, No. 65. pp. 127–134. April. — WHEELER, W. M. The Free-Swimming Copepods of the Woods Holl Region. *Bull. U. S. Fish Com.*, 1899. pp. 157–192, 28 figs.

Anales del Museo Nacional de Montevideo. Tomo iii. Fasc. xiii. — *Boletin do Museu Paræense.* Vol. iii, No. 1. February. — *Bull. Johns Hopkins Hospital.* Vol. ii, No. 114. September. — *Insect World.* Vol. iv, No. 7. July. — *Memorias y Revista de la Sociedad Científica "Antonio Alzate."* Tom. xiv, Nos. 7–8. — *Modern Medicine.* Vol. ix, No. 7. July. — *Revista chilena de Historia Natural.* Año. iv, Nos. 5–7. May–July. — *Science Gossip.* New Series. Vol. vii, No. 75. August.

(*No. 405 was mailed September 27.*)